Patent Application of Theodore E. Anvick for Anvick Aperture Device and Method of Forming and Using Same

Cross References to Related Applications

Not Applicable

Background -- Field of Invention

This invention relates to the design of framework for the reinforcement of structures, including reinforcement for cementations, more particularly, the invention relates to an ***aperture*** reinforcement device that girds and cinctures other reinforcement in order to enhance composite and ductile properties of reinforcement arrays.

Background – Description of Prior Art

U.S. patent 6,226,942 to Bonin; Pete J. (05/08/2001)

U.S. patent 6418686 to Record, (07/16/2002)

U.S. patent 3879908 to Weisman, Victor P. (04/29/1975)

U.S. patent 4,226,067 to Artzer, Richard, F. (10/07/1980)

U.S. patent 4,576,372 to Grutsch; George A. (05/14/1985)

U.S. patent 4,530,191 to Boisbluche; Arsene G. (07/23/1985)

U.S. patent 4,624,089 to Dunker; Friedrich W. (11/25/1986)

U.S. patent 4,660,341 to Holtz; Neal (04/28/1987)

U.S. patent 4,702,053 to Hibbard; Donald B. (10/27/1987)

U.S. patent 4,715,155 to Holtz; Neal (12/29/1987)

U.S. patent 4,998,393 to Bacna; Juan A. M. (03/12/1991)

U.S. patent 5,058,345 to Martinez; Manuel J. (10/22/1991)

U.S. patent 5,398,470 to Ritter; et al. (03/21/1995)

U.S. patent 5,440,845 to Tadros; et al. (08/15/1995)

U.S. patent 5,487,248 to Artzer; Richard F. (01/30/1996)

U.S. patent 6,088,985 to Clark; Timothy L. (07/18/2000)

U.S. patent 6,237,297 to Paroloy; Richard (05/29/2001)

U.S. patent 6,272,805 to Ritter; et al. (08/14/2001)

Until now current and previous truss and panel designs have provided valid construction alternatives to more traditional configurations of building material. However, they have been unfamiliar to and have not been embraced by a construction industry well versed in prevalent wood, concrete masonry and steel building methods. Adoption of more stringent mandatory building code requirements with respect to seismic, wind, and fire resistance and energy conservation has progressed over the years, land and labor costs have risen,

and the cost of raw materials has increased. This has caused the costs of the development of wood, steel frame, masonry block and poured in place concrete structures to rise significantly. Rising maintenance, and energy costs for finished structures have also increased the costs of operation and ownership. The benefits of truss and panel designs address all of these factors, and as a result, their price competitiveness has become apparent, reducing the resistance of the construction and fabrication industries to their use as mass production construction techniques. Both the construction industry and consumers will benefit from the development of faster, stronger, more durable and energy efficient construction techniques and structures employing them.

Trusses and ***composite trusses*** of various kinds have been constructed *over* the years with a variety of designs, connections, methodology and materials. Some have been designed into space frames as the reinforcement matrix for structural panels with facings of cementatious material. In all such panels, the optimization of structural strength, ductility and consequent composite behavior is clearly desirable. Some have featured a disposition of elements attached so as to form loops or ***apertures*** of reinforcement. Such *apertures* have served to elaborate the embedment of reinforcement in cementations in an attempt to enhance composite action. However, such panels have been deficient in their ductility, that is, the ability to undergo changes of form without breaking or falling apart.

Building panels of various kinds have been developed over the years incorporating a variety of external facings, reinforcement, and internal insulating materials. Prefabricated panels are factory made and shipped to a site for assembly into interior and exterior walls of a building. Some panels are also made directly at the building site. Such prior panels typically have a framework, commonly of wood or metal studs and or wire, readymade with an insulative core and sometimes incorporating electrical wirings and plumbing. Prefabricated panels have means for attachment to each other along abutting edges and for attachment to roof trusses, rafters, flooring and foundations. Panels have been

constructed to withstand the various types of forces that buildings typically undergo such as compression forces from floor loads and roofs. Such panels have also been designed to provide insulation, weather-tight sealing, and to be connected to adjacent panels, roof systems, and to footers. The panels have typically been connected to roof trusses or rafters using conventional brackets, which are nailed to the wooden rafters or trusses and to wooden headers.

The brackets are designed to withstand the forces exerted by seismic events and the lifting forces exerted upon roof structures by wind. The structural systems of a building resist such forces well to the degree that they enable the building to behave as a unit under stress rather than failing at points of attachment or across surfaces, weakening the structure and making it susceptible to catastrophic failure. The degree of composite, or unitized, behavior of a structure and of the elements used to build it increases with increased ductility of structural interconnection.

The present invention is directed towards a means to construct monolithic composite insulated structures from elements that can comprise a panel system and that address composite behavior and ductility of structures. Said structure not only provides superior strength against compression and tension forces longitudinally, and laterally, and transversely but also anchors, braces, positions and strengthens structural trusses in a truss system. Walls, roofs, floors, and foundations are tied together in such a manner as to provide a greatly increased tension and compression and shear strength and resistance to lifting and shaking forces.

Brief Description of the Drawings

Fig. 1A is a Curvilinear web element.

Fig. 1B shows a truss with apertures formed between web vertices and dual attached cords.

Fig. 1C shows a truss with apertures formed between angled vertices and

attached cords.

Fig. 1D1 shows one pair of parallel trusses 12a in an array to form a panel assemblage.

Fig. 1D2 shows one pair of intersecting trusses 12b in an array to form a panel assemblage.

Fig. 1E shows a longitudinal cross section of a plurality of trusses 12b Fig 1C in an array to form a panel assemblage Fig 1D.

Fig. 1F and G show ductile right angle truss aperture interconnections (e.g. wall and floor).

Fig. 2A shows truss aperture formation by weaving of the web element over the cord.

Fig. 2B shows lateral reinforcement cinctured by apertures formed by alternating web vertices.

Fig. 2C is a lateral cross section of a wrapped web cincturing both cord and lateral reinforcement.

Fig. 2D is a longitudinal cross section of a woven web aperture cincturing cords and a lateral.

Fig. 3A is a view of an independent locatable cincturing device.

Fig. 3B is a view s of an independently locatable cincturing aperture device.

Fig. 3C shows reinforcement cinctured at a right angle by the aperture shown in figures 3A and 3B.

Fig. 3D shows cincturing of a point loaded dual web, lateral reinforcement, a cincture-tightening bar and a longitudinal cord.

Fig. 3E, 3F show differing views of an alternate independent aperture device.

Fig. 3G, 3H show crossing and lapping cinctured by an independent aperture device, 3H showing a ductile lap connection.

Fig. 3I shows another independently locatable aperture.

Fig. 3J, 3K show the use of the aperture drawn in 3I.

Fig. 3L shows a locatable aperture restraining reinforcement at a cord and vertex cincture.

Fig. 3M shows Mesh reinforcement cinctured between cords and lateral via truss aperture, the mesh in turn serving as a locatable cincturing device.

Fig. 4A shows an insulative panel core element grooved to position and dispose truss webs.

Fig. 4B shows a truss with curvilinear web integrated into grooves of an insulative core element and sheeting elements cinctured between the perpendicular cords.

Fig. 5A shows a foundation conection, truss, core, and cementation design alternative.

Fig. 5B, 5C show composite formats with alternative aperture and positioning devices.

Reference Numerals

6, 6 a-j Web vertices, vertices of independently locatable elements

7, 7 a,b Web

8, 8 a,b Cord of truss or longitudinal reinforcement

8 c,d Lateral or cross reinforcement element

11 ***Aperture***

11 a, b Positionable truss ***aperture*** for ductile inter-truss connections

12 a, b, c Truss

13 a-j Independently locatable cincturing aperture devices

13 a Locatable CU clip element

13 c Locatable W clip element

13 f Cinctured sheeting element

13 g Cinctured / cincturing lattice or welded wire fabric

13 h, i, j Alternate locatable apertures

14 Positioning Groove

15 Insulative core element

16 Core longitudinal by transverse face

17 Sheeting element

18 Aperture footing reinforcement members

19 Aperture truss footing reinforcement and longitudinal member spacing element

20 Cementations

21 a,b Core restraining element

Preferred Embodiment -- Description

A preferred embodiment of the ***aperture*** **11** of the present invention is comprised of a continuous reinforcement element **7** shown in **(Fig 1A)** bent to a curvilinear waveform forming vertices **6** and comprising a web **7** of a truss **12a (Fig 1B)** formed by affixing one or more chords **8a, 8b** to said web **7** at a predetermined location such that each vertex **6** extends beyond the attachment location of cords **8a**, **8b** forming an ***aperture*** of predetermined size. An array of reinforcement comprised of a plurality of trusses **12a (Fig 1B)** are integrated into a space frame shown in **(Fig 1D1)** of predetermined length, width, and thickness by the insertion and attachment of lateral reinforcement **8c,d** of predetermined size through aligned ***apertures*** **11** of spaced trusses.

Truss **12a** may be disposed in spatial relationships with its neighbor by elements of an insulative core shown in **(Fig 4A)**, whose grooved transverse faces **16** fit the central web area of trusses **12a**. Space frame **(Fig 1D1)** is built up from interspersed trusses **12a** and insulative core elements **15**. The predetermined dimensions of core elements **15** dispose and establish truss **12a** spacing and truss **12a** in turn positions core elements **15** in relation to space frame **(Fig 1D1)** reinforcement attachments to allow required embedment in the event cementations **(20)** are applied.

In another preferred embodiment ***aperture*** **11 (Fig 1C)** is formed in truss **12b** by attachment of cords **8a,b** to web **7**. Cords **8a,b** are distinguished by being

located on laterally opposite sides of web **7** without regard to their transverse relative position. Vertices **6** of web **7 (Fig 1C)** are bent at equal but opposite angles on transversely opposite sides of web **7 (Fig 1C).** A space frame **(Fig 1D2)** comprises a plurality of trusses **12b** with each truss **12b** rotated 180 degrees from its neighbors around a transverse axis. Then each truss **12b** in a given plurality is spaced, positioned and rotated equally and in opposite directions from its neighbors around a longitudinal axis so that the angled vertices **6a** **(Fig 1D)** of neighboring trusses **12b** lie flush with each other, sandwiched between two cords **8a** or **8b**. Paired ***apertures*** **11 (Fig 1D)** are then integrated laterally by the insertion of lateral reinforcement **8c,d** through and attachment to aligned apertures **11** comprised of the bounding vertices **6** and cords **8a,b** of the space frame array **(Fig 1D).**

Space frame **(Fig 1D2)** is shown in longitudinal cross section in **(Fig 1E)** presenting a folded plate truss structure comprised of lateral reinforcement cords **8c,d** interconnecting and cinctured by apertures **11** formed by vertices **6a** and longitudinal truss cords **8a,b**. Truss web elements **7** serve in longitudinal, lateral, and transverse truss structures intersecting, in space frame **(Fig 1D2),** to form substantially quadrilateral-based pyramidal structures. Each pair of vertices **6a** and cincturing apertures **11** form the apex, or summit vertex, of a pyramidal structure and also one corner of the square base of a neighboring inverted pyramidal form. The intersecting folded plate truss structures of the space frame **(Fig 1D2)** and **(Fig 1E)** thus provide three dimensional structural action. In this preferred embodiment appropriately shaped and grooved core elements similar to **(Fig 4A)** may also used to dispose, position, and assemble space frames **(Fig 1D2)** from trusses **12b** and lateral reinforcement **8c, 8d** forming modular panelized insulative core and reinforcement components for embedment in cementations.

In another embodiment perpendicular ductile truss ***aperture*** connections **11a, b** in which ***apertures*** **11 (Figs 1G and 1H)** arenformed by two connected web

elements of a truss are overlapped in the area of truss interinterconnection such that lateral reinforcement **8c, 8d** passes through ***apertures*** of both trusses at interconnection points **11a** and **11b**.

***Apertures* 11 (Fig 2A)** are formed by the weaving and attachment of web **7b, 7a** elements around dual cords **8b, 8a** to form vertices **6b, 6c** each of which wraps one cord **8a, 8b** to form cincturing vertex **11**.

A truss **12 (Fig 2B)** is configured with vertices **6d, 6e** alternating from side to side of a single cord **8** forming cincturing ***apertures* 11** girding lateral reinforcement **8c, d**.

***Apertures* 11** are formed **(Figs 2C and 2D)** by the bending, weaving, sewing, or tying of web **7**. A lateral cross section view of an ***aperture* 11** thus formed **(Fig 2C)** shows lateral and longitudinal cords **8** and transverse reinforcement **8c, d** girdled and cinctured by web **7**. Three vertices **6h, i, j** and three ***apertures* 11** are formed.

A longitudinal cross section view is shown **(Fig 2D)** of two truss cords **8a, 8b** and perpendicular lateral reinforcement **8c, d** girdled and cinctured by ***aperture* 11** formed by continuous web **7** on a similar principle of bending, weaving, sewing, or tying.

***Apertures* 11** are formed by independently locatable cincturing aperture reinforcement elements **13** of predetermined dimensions **(Figs 3A and 3B)**.

In **(Fig 3C)** an application of locatable cincture **13a** cincturing two reinforcement elements appears. Cincture **13a** saddles one reinforcement element **8**, and the second is then communicated through the girding apertures formed between the saddled reinforcement **8** and the vertices **6g** or **6h** of cincture **13a** left unoccupied by the saddling procedure.

An application of locatable cincture **13b** to web **7**, cord **8**, and lateral reinforcement **8c, d, 8e** appears in **(Fig 3D)**.

Views of locatable cincture **13c** applicable as described for cincture **13b** by saddling and insertion of reinforcement appear in **(Fig 3E and 3F)**.

Cincture **13d** used for both crossing and lapping reinforcement appear in **(Figs 3G and 3H)**.

(Figs 3I through 3M) show the form and application of locatable cincturing devices.

Preferred Embodiment -- Operation

The manner of using the ***aperture*** device **11** is adaptable to structural requirements of any given form or disposition. Panels can be fabricated and erected as framework reinforcement at site as follows:

In a preferred embodiment an element of said core **15,** panels are placed on a horizontal surface with an edge **16** facing upward which has been grooved **14** to fit and position a truss **12**. In this example, two opposite edges **16** of the core panel **15** element are grooved **14**. An adhesive is applied to said edge **16** and an element of an ***Anvick aperture* (11) *composite truss* 12a-c** configuration is fitted within the preformed grooves **14** which accept half of the girth of the webbing element **7** and position said element with respect to said core panel **15.** A corresponding grooved core panel **15** element is fitted on top of the first element and completes the embedment of the first truss **12** configuration. The positioning is such that there is sufficient clearance between the core panel element **15** and reinforcement elements **8a,b,c,d** for required embedment in cementations **20**. This process is repeated, the core panel elements **15** aligned flush with each other and positioning the truss **12** array, until the desired panel width is assembled. Once said adhesive has set the panel can be set in place on an arrangement of reinforcement protruding in a predetermined spatial relation from a previously formed foundation structure **18**. Independently locatable ***aperture*** cincturing devices **13a-j** attach the foundation reinforcement **18** to either the lateral **8c,d** or longitudinal **8a,b** reinforcement elements when the ***aperture*** connecting lateral reinforcement **8c,d** are inserted through the ***apertures*** **11**. Welded wire fabric **13g,** or sheeting elements **13f, 17** can be installed, if called for, prior to the addition of said lateral reinforcement **8c,d,** which then serves to cincture **13g**, said fabric, when installed over it. System components alternatively may be fabricated off site.

The manner of using ***aperture*11** in another preferred embodiment requires each truss **12b** in a given plurality to be spaced, aligned, and then rotated in an opposite direction from adjacent trusses **12b** so that they intersect at their corresponding ***apertures*** **11.** Said ***apertures*** **11** of said adjacent trusses **12b**

are bent at an angle to the web **7** so that they lie flush with one another. Cords **8a and 8b** of said trusses **12** sandwich the attached, paired, flush positioned vertices **6a** forming paired ***apertures*** **11**. Reinforcement **8c,d** is then inserted and communicated through and girded within said ***apertures*** **11** to complete an embodiment's basic array. The resulting array is a folded plate structure with multidirectional truss behavior. Said curvilinear and or wave form webbing **7** provides for a real three dimensional structural action once connecting reinforcement **8,c,d**, foudation connections **18**, and cementations **20** are installed.

In this preferred embodiment a truss **12b** structure is elaborated by assembling said trusses **12b** edge to edge in planes which intersect at longitudinal lines of vertices **6a**. Said parallel longitudinal intersections linked by cords **8a,b** alternate transversely from side to side of the resulting three dimensional space frame disposed across thelateral axis of the space frame array.

Aligned sequences of paired cincturing vertices **6a** are linked when lateral reinforcement **8c,d** are passed through vertices **6a**. The linked vertices now also lie along the intersection at reinforcment **8c,d** of planes formed by the curvilinear web elements **7** of trusses **12b** which intersect at parallel lateral lines of aligned vertices. Said parallel lateral intersections alternate transversely from side to side of the three dimensional space frame disposed along the longitudinal axis of the space frame array. Longitudinal and lateral cross sections of the space frame consequently resemble each other, the two sets of intersecting planes presenting triangular cross sectional forms of a folded plate truss structure in both directions. The two sets of intersecting planes, each crossing the lateral axis, formed by trusses **12b,** and their web and lateral reinforcement elements along both longitudinal and lateral axes of a consequent space frame intersect to form substantially square based pyramidal structures. Each cinctured vertex **6a** of a frame is one corner of the square base of one or more said structures, depending upon location at an edge, corner, or in the field of a panel of this configuration of space frame, as well as summit vertex **6a** of an inverted neighboring one, the alternate square bases forming the substantially planar transversely opposite surface lattices of the space frame. Consequently the transverse as well as the longitudinal and lateral cross sections presents similar triangular forms of a

folded plate structure and the space frame array of the embodiment affords true three-dimensional truss operation.

Other Embodiments

Independent aperture -- Description

A continuous loop of reinforcement bent, woven, folded, tied, sewn, twisted or otherwise formed to conform to reinforcement in the array to provide means for the girding or cincture of at least two elements of the reinforcement array.

Independent aperture -- Operation

Independently locatable apertures can be shaped in a variety of ways. When placed onto the array locatable apertures require cross reinforcement to be communicated into and held disposed within said aperture to effect installation of said aperture.

Double webbed Trusses -- Description

Trusses with apertures that contain at least one cord and at lease two web elements generally juxtaposed to one another to form, when viewed in the lateral cross section, opposing vertices across the transverse axis.

Double webbed Trusses -- Operation

All aperture trusses operate in a similar fashion and methodology, each having distinct differences in an engineered analysis.

Foundation or grade beam reinforcement -- Description

Trusses equipped with aperture devices are positioned to space, align, and support reinforcement extending through and between foundation cementations and connecting structures. Reinforcement passed through parallel or perpendicularly aligned vertices of such attached structures provides ductile, composite connections. In arrays in which vertices accept lateral reinforcement in perpendicular planes, said lateral reinforcement may be interlapped to cincture the structures together. Similarly such use is appropriate and desirable for bond beam construction.

Foundation or grade or bond beam reinforcement -- Operation

Trusses of a beam system are oriented to trusses of a wall or foundation system such that vertices of the trusses align, thus allowing one or more elements of lateral reinforcement to pass through the vertices of both systems. In some orientations the cords of the trusses of the systems may be juxtaposed so that their vertices accept interlapped transverse reinforcement cincturing the systems together with a ductile connection when embedded in cementations.

One Cord Truss – Description

An asymmetrical truss with vertices bent in such a manner that said vertices grab or gird reinforcement such as the cord of another truss when cross reinforcement is disposed within said truss's apertures to provide means for additional lateral or longitudinal reinforcement and load resisting capacity.

One Cord Truss -- Operation

This device is used at openings in arrays by attaching the un-corded and bent vertices to longitudinal or lateral cords in an array and cincturing said one cord truss to said array with cross reinforcement.

Conclusions, Ramifications, and Scope

Accordingly, it can be seen that the Anvick composite ***aperture*** connection of this invention can be used in structural cementations and other hybrid material structures.

The walls can be pre assembled, or pre-formed, offsite according to the required dimensions and then transported to the job site.

Rapid installation.

Can be made from 100% recycled materials.

Reduces demand on energy.

Structurally more efficient.

Materials and labor force readily available worldwide.

Meets extreme climactic, environmental and seismic challenges.

More durable structures.

Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Various other embodiments and ramifications are possible within it's scope. For example; a continuous element can be formed into an entire panel array forming transverse, lateral, and longitudinal elements from one continuous element. Simple trusses of conventional reinforcement bar can be permitted by building officials without need for testing. Elements of differing configurations can be intermixed throughout an array. And many other potential configurations can be made.

Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.